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ABSTRACT

Two studies are reported. The first is based on Piaget's assertion that the child's representation of his world is dependent on the level of cognitive development at which he is currently functioning. Forty-eight normals and 48 retardates were given a visual memory task. They were asked to recall a configural presentation in a number of ways, immediately, one week after, and 6 months after the initial presentation. Piaget's proposition that memory is an integral part of intelligence is given support. Normals were found to be superior to retardates on the task. Similar findings are reported in a 2nd study which focused on a seriation task: (1) significant improvement did not occur in the performances of the youngest group, suggesting that the schema of seriation was incompletely developed; and (2) overall, the performance of normals exceeded that of retardates over time, even though the groups had been matched for MA and CA. It is suggested that conditions present in the mentally retarded preclude the improvement noted in normals of equivalent mental ages. (TL)

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LONG-TERM MEMORY IN NORMALS AND RETARDATES [1, 2]

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INTRODUCTION

Present consideration centers on the development of operatory thought: i.e., cognitive processes - and its relation to the memory process in normals and retardates. Interest is in the basic capacities and dispositions which the learner brings to the experimental situation and which determine the initial retention and immediate storage of information subsequently to be recalled or retrieved.

Rather than being a distinct behavior, Piaget suggests that memory is a special case of intelligence (1968). When an individual is presented with an object future representations rely on the level of cognitive development that the person has attained (at the time of recall): i.e., if presented with an arrangement of geometric shapes, the subject's memory for this arrangement will be enhanced if he has reached the level of operations which allow him to work with classificatory problems.

A result of the Genevan memory research was to show the developmental difference among three types of memory: recognitive, reconstructive, and evocative. Recognitory memory depends on perception alone: i.e., no understanding, no higher levels of intellect are needed for recall. Evocative memory requires some form of operational development: i.e., representational thought is necessary for

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reproduction. Hence, while recognitory thought is present in young children and sub-human organisms, evocative memory must wait for higher levels of operational development.

Between recognitive and evocative memory is an intermediate type of memory designated as reconstructive memory. This form of memory is employed when the subject is asked to reconstruct, from a random assortment of objects, a stimulus form or arrangement seen earlier. Through recognitory memory the subject will recognize the parts of the stimulus object. Since elements must be arranged into the previously-viewed configuration, thus calling for classificatory skills, evocative memory also enters into the task (Piaget, 1968).

Memory Research from a Cognitive Point of View

Although there are many studies in the literature delving into the processes of memory and the effects it may have on learning there are few which follow Piaget's paradigm. Research carried out by Inhelder and Piaget most clearly represents the Genevan hypotheses. In one study (Piaget, 1968) children, ages 3-7, were shown an ordered array of sticks which varied in size from nine to fifteen centimeters. One week after presentation each subject was asked to draw what he had seen the previous week. Finally, six months later, a second drawing was requested.

Three interesting findings evolved from the Genevan study. First, one week representations suggested that retention was not necessarily comprised of the perceived stimulus, but instead was a replica of what had been assimilated in the subject's schematic organization. For example, 3- to 5-year old subjects had reached an operational level which allowed them to reproduce sticks of equal length. At more advanced levels and as understanding of seriation occurred the subjects were able to represent the stimulus as an ordered array.

A second finding was that all subjects "claimed" they remembered the stimulus object. However, when given the opportunity to demonstrate the memory by a drawing, it was noted that there were marked discrepancies between what subjects thought they remembered and empirical memory evidence: i.e., rather than remembering the complete configuration, a majority of subjects retained only a part of the configuration.

Finally, 74% of the subjects in the study were found to have increased recall: i.e., their drawings of the initial configuration indicated better recollection at six months than at one week. These results led Piaget and Inhelder to conclude that memory is a coding process, and when improvement occurred it was the operational structures that had become modified, a scheme or system more adequately structured than before. The six-month drawing was indicative of the current operative level, not of the level at which the subject previously operated during the initial presentation (Inhelder and Sinclair, 1968).

The study previously discussed dealt with memory tasks demanding seriation abilities. Children who are entering school are generally able to complete such tasks. In a second study reported by Inhelder and Sinclair (1968) a stimulus representing a higher level of operatory thought involving classificatory ability was employed. As illustrated in Figure 1, subjects were presented with a board on which geometric figures were arranged two by two (side by side).

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Insert Figure 1

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Based on previous theory it was hypothesized that the only subjects who would be able to remember the figure would be those who had reached the level of operations (8 to 12 years) at which combinatory problems could be successfully handled. Scores obtained six months after viewing the configuration were an improvement

Figure 1

over scores obtained one week after viewing. Only older subjects could successfully complete the task: i.e., closely reproduce the initial stimulus configuration. However, the increased scores of younger subjects suggested operatory development.

Recent research by Altmeyer et al. (1968) substantiated results reported by Inhelder and Sinclair (1968). Approximately 100 kindergarten children were shown the ordered array of seriated sticks. Significant improvement in memory for the array was noted across the six-month period. Recall questions directing the subject's thought to size, shape, or color of the sticks did not differentially facilitate or inhibit recall. Finally, to determine whether children's drawings become ordered as a function of age rather than memory, the authors asked for random drawings of sticks from three age groups - kindergarten, first, and second graders. If results of these analyses suggested specific patterns of construction then one might assume that there is an inherent ordering in Piaget's stick task since these subjects had never seen a specific ordering of the sticks. There were no differences between the groups relative to ordering or patterning: i.e., no specific patterning of the sticks was produced by any group. Thus, it seemed likely that "memory" for the initially presented array significantly contributed to the results. Any ordering that was produced relied on operational thought.

Studies reviewed tend to be supportive of Piaget's assertion that the child's representation of his world is dependent on the level of cognitive development at which he is currently functioning. There is need to study these processes in a retarded population to determine if the hypotheses obtain. To this end the present investigation attempts to assess the development of memory processes in retardates and normals.

Methodology

The sample (N=96) included 48 normals, ages 8-18, WISC or WAIS IQ 90-110, and 48 retardates, ages 8-18, WISC or WAIS IQ 50-75. The subjects were randomly selected (random numbers technique) from regular and special education classrooms in the Neshaminy and Pennsbury, Pennsylvania, school districts. Stratification in terms of socio-economic class was accomplished through use of Warner's Index of Social Characteristics.

Procedure

The approach employed by Inhelder and Sinclair (1968) was followed in the current investigation. Initially, the subject was presented with a board on which geometric shapes (circles, rectangles, and diamonds) were pasted in an ordered side-by-side arrangement in groups of three (see Figure 1). The subject was asked to look at the stimulus configuration and describe what he saw. After giving the subject three minutes to view the arrangement, the board was taken away. The subject was then asked to draw what he had just seen.

The week after the initial presentation of the configuration the subject's memory for it was assessed. First, the subject was asked to describe and then draw what he had seen previously. After the drawing was completed, a randomized group of geometric shapes was presented for arrangement with the directions "now make what you saw before".

Finally, after six months had elapsed, each subject was again asked to (1) describe, (2) draw, and (3) arrange the shapes he had previously been required to reproduce one week after the initial viewing. No time limit was placed on the drawing on any of the three occasions.

Prior to data gathering a pilot study was conducted to determine the difficulty of the task for retarded subjects of the same age and IQ as those in the present sample. The results indicated that methodologically the task was not too difficult for the subjects: i.e., they understood the directions and had little difficulty in drawing the objects.

Finally, subjects who had never seen the arrangement were asked to "draw circles, diamonds, and rectangles" to determine if a basic ordering of these objects existed. Results indicated that no order existed among those samples: i.e., in general, both normal and retarded subjects drew only one circle, one rectangle, and one diamond.

Scoring System

Both memory drawings and arrangements were scored on a zero-to-eight point scale adapted from Inhelder and Sinclair (1968). Response content was assessed rather than aesthetic quality: i.e., the extent to which the representation resembled the original figure was of prime interest.

In an effort to establish inter-rater reliability correlations were generated from data scored by two judges. Coefficients ranged from .93 to .99, suggesting a high degree of inter-rater reliability.

Results

Retention scores for all subjects were included in the data analyses. These scores represent the amount of information retained by the individual immediately, one week, and six months after the initial viewing of the configuration. Two types of retention scores were obtained: (1) drawing - S was required to draw the original configuration from memory at the three previously mentioned intervals, and (2) re-

construction - after giving memory drawing at one week the subject was given a random assortment of geometric figures from which he was to reconstruct the original configuration.

Means and standard deviations were employed as indices of central tendency and dispersion. The results of these analyses are set forth in Table 1. Drawings I, II, and III represent memory drawings - immediate, one week, and six months respectively. Reconstruction I and II signify memory reconstruction at one week and six months.

A four-factor (2 x 3 x 2 x 3) analysis of variance with repeated observations on the fourth factor was applied in an effort to determine if "within" and "across" group differences existed on the memory drawing task. A weighted means solution was obtained to control for unequal cell means. Results of this analysis are found in Table 2.

Perusal of Table 2 indicates that memory drawing scores for normals and retardates were significantly different; normals' performance on the memory drawing task was superior to that of retardates'. Post hoc tests using Dunn's procedure (Kirk, 1969) yielded significant mean differences at all three intervals - immediate, one week, and six months. Also noted is the fact that a significant age effect was present. In general, as age increased scores increased. Finally, a significant main effect for time was obtained. Drawings became less representative of the original configuration over the six-month period. Perusal of Table 1 suggests that this loss was greatest in the one-week to six-month interval. Multiple comparisons among the replication factor means support this observation; i.e., one-week scores were significantly larger than six-month scores in both normals and retardates.

TABLE 1

MEANS AND STANDARD DEVIATIONS FOR NORMALS AND RETARDATES

Groups	Drawing I		Drawing II		Drawing III		Reconstruction I		Reconstruction II	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Normals										
16-20										
Male	8.00	.00	7.43	.53	5.71	2.63	7.57	.53	5.57	2.99
Female	7.60	.55	7.80	.45	5.60	2.61	7.80	.45	6.80	1.10
12-16										
Male	7.20	1.55	5.80	2.04	3.90	2.47	6.50	1.43	5.30	1.77
Female	7.60	.52	7.80	.42	5.60	2.41	7.70	.48	7.10	2.02
8-12										
Male	6.25	1.83	4.63	2.67	4.00	2.07	5.50	2.00	4.00	2.00
Female	6.63	1.69	5.38	2.62	4.25	2.60	6.50	2.27	5.75	2.87
Retardates										
16-20										
Male	5.43	2.64	3.29	2.98	1.29	.49	4.57	2.37	1.71	.95
Female	4.80	2.86	4.00	2.00	1.80	1.30	4.40	2.41	2.20	1.30
12-16										
Male	5.00	2.62	3.90	1.97	2.10	1.66	4.60	1.84	2.20	1.87
Female	4.80	2.49	4.20	2.15	3.10	1.37	5.60	2.01	3.30	1.25
8-12										
Male	4.25	2.12	4.63	2.72	2.38	1.19	4.63	2.56	2.88	.99
Female	2.63	2.33	2.88	1.89	1.63	1.06	3.50	1.51	2.50	1.07

TABLE 2

ANALYSIS OF VARIANCE FOR NORMALS AND RETARDATES - DRAWING

Source of variation	SS	df	MS ($\widetilde{N}$)	F
Between subjects				
A (Normal/Retardate)	66.34	1	499.55	77.81 *
B (Sex)	.27	1	2.02	
C (Age)	8.75	2	32.94	5.13 *
AB	1.59	1	11.99	
AC	3.35	2	12.62	
BC	2.65	2	9.96	
ABC	1.75	2	6.59	
Error (between)	539.55	84	6.42	
Within subjects				
R (Interval replicates)	36.74	2	138.34	48.80 *
AR	.04	2	.17	
BR	1.21	2	4.54	
CR	1.08	4	2.04	
ABR	.29	2	1.09	
ACR	2.83	4	5.33	
BCR	.45	4	.83	
ABCR	.30	4	.56	
Error (within)	473.86	168	2.88	

* $p < .01$

Attempt was made to assess the reconstructive memory - i.e., ability to reconstruct the original configuration from a random assortment of geometric figures - or normals and retardates through use of a four-factor analysis of variance. Table 3 contains the results of this analysis. Again, normal and retardate differences obtain.. Both post hoc tests indicated that these significant differences existed on the initial and the six-month reconstruction. Similarly, the replication factor reached significance; results set forth in Table 1 indicate scores decreased as a function of time.

Two findings in the reconstruction analyses were of interest. First, no significant age differences were obtained. Younger and older subjects were equally able to perform the task. Secondly, the main effect of sex approached significance at the .05 level of confidence. Results of post hoc analyses indicicated that no significant sex differences occurred in this taks at any of the three levels in normals or retardates.

Tests for trends were carried out by sub-group (males and females of different ages) to determine the best fitting function of the data. Results of these analyses are set forth in Table 4. Significant linear trends were obrained in nine of the twelve tests, indicating an inverse relationship between time (6-month period) and retention.

Discussion

Present interest has centered on the investigation of the memory processes of normals and retardates. Piaget and his associates have proposed that memory is not separate from, but an integral part of, intelligence. A child's representation of the world is said to be dependent on his current level of cognitive development. Hence, one would expect the representations of retardates to be less mature than

TABLE 3

ANALYSIS OF VARIANCE FOR NORMALS AND RETARDATES - RECONSTRUCTION

Source of Variation		SS	d/f	MS (N)	F
Between subjects					
A	(Normal/Retardate)	45.38	1	241.67	84.99 *
B	(Sex)	2.11	1	15.91	3.95
C	(Age)	2.74	2	10.30	
AB		1.17	1	3.31	
AC		2.97	2	11.18	
BC		.58	2	2.17	
ABC		1.26	2	4.75	
Error (between)		350.94	87	4.02	
Within subjects					
R	(Interval replicates)	17.61	1	132.63	56.20 *
AR		.83	1	6.24	
BR		.34	1	2.57	
CR		.66	2	2.50	
ABR		.00	1	.01	
ACR		.18	2	.69	
BCR		.30	2	1.12	
ABCR		.04	2	.17	
Error (within)		205.58	87	2.36	

* $p < .01$

TABLE 4

TESTS FOR TRENDS

Source	df	SS	MS	F
NORMALS 16-20 - MALES				
Linear Trend	1	18.29	18.29	7.05 *
Deviation	13	33.71	2.59	
Quadratic trend	1	1.52	1.52	.57
Deviation	12	32.19	2.68	
NORMALS 12-16 - MALES				
Linear trend	1	54.45	54.45	27.55 **
Deviation	19	37.55	1.98	
Quadratic trend	1	0.42	0.42	0.20
Deviation	18	37.13	2.06	
NORMALS 8-12 - MALES				
Linear trend	1	20.25	20.25	9.37 **
Deviation	15	32.42	2.16	
Quadratic trend	1	1.33	1.33	0.60
Deviation	14	31.08	2.22	
NORMALS 16-20 - FEMALES				
Linear trend	1	10.00	10.00	3.46
Deviation	9	26.00	2.89	
Quadratic trend	1	4.80	4.80	1.81
Deviation	8	21.20	2.65	
NORMALS 12-16 - FEMALES				
Linear trend	1	20.00	20.00	8,64 **
Deviation	19	44.00	2.32	
Quadratic trend	1	9.60	9.60	5.02 *
Deviation	18	34.40	1.91	
NORMALS 8-12 - FEMALES				
Linear trend	1	22.56	22.56	5.46
Deviation	13	56.77	3.78	
Quadratic trend	1	0.02	0.02	0.01
Deviation	14	56.75	4.05	

TABLE 4 - TEST FOR TRENDS (cont.)

Source	df	SS	MS	F
	RETARDATES - 16-20 - MALES			
Linear trend	1	60.07	60.07	13.96 **
Deviation	13	55.93	4.30	
Quadratic trend	1	0.02	0.02	0.01
Deviation	12	55.91	4.66	
	RETARDATES 12-16 - MALES			
Linear trend	1	42.05	42.05	12.76 **
Deviation	19	62.62	3.30	
Quadratic trend	1	0.82	0.82	0.24
Deviation	18	61.80	3.43	
	RETARDATES 8-12 - MALES			
Linear trend	1	14.06	14.06	3.23
Deviation	15	65.27	4.35	
Quadratic trend	1	9.19	9.19	2.29
Deviation	14	56.08	4.01	
	RETARDATES 16-20 - FEMALES			
Linear trend	1	22.50	22.50	10.04 *
Deviation	9	20.17	2.24	
Quadratic Trend	1	1.63	1.63	0.71
Deviation	8	18.53	2.32	
	RETARDATES 12-16 - FEMALES			
Linear trend	1	14.45	14.45	5.69 *
Deviation	19	48.22	2.54	
Quadratic trend	1	0.42	0.42	0.16
Deviation	18	47.80	2.66	
	RETARDATES 8-12 - FEMALES			
Linear trend	1	4.00	4.00	2.50
Deviation	15	24.00	1.60	
Quadratic trend	1	3.00	3.00	2.50
Deviation	14	21.00	1.50	

* p .05; ** p .01

those of the normal child of equivalent CA. Also, a direct relationship between age and memorability would be anticipated. Results of the present study tend to confirm the above hypothesis. Normals were found to be superior to retardates on the memory tasks; as age increased memory drawings more closely approximated the original configuration. However, in the reconstruction phase of the investigation no significant main effects for age were obtained. A ceiling effect may explain this finding: i.e., the task was equally easy for both younger and older subjects. The result was anticipated since previous research had indicated that this ability was attained early in a child's life (Piaget, 1968). Thus, the current findings support Piaget's assertion that there are developmental stages of memory. Reconstructive memory systems (retrieval of information through use of cues) are developed prior to evocative systems (operationally defined by memory drawings).

A second hypothesis advanced by the Genevan School posits that since a child's representation of the world depends on his current level of cognitive development his memory drawings may mature as the time interval between initial and final recall sessions increases. This hypothesis has found general support in studies by Altemeyer et al. (1969) and Dahlem (1968; 1969). The reason that Ss in the present study exhibited significant loss of memory may be that the task (drawing from memory without concrete cues) was too difficult for the group as a whole: i.e., they had not reached a level of operations which would allow them to utilize Strategies necessary for successful completion of the task. The problem presented to the subjects required grouping and classification schemas which they may not have acquired. Recent research by Stephens et al. (in press) suggests that these processes may not be totally achieved until age 17 or above. Results of the reconstruction phase of the research suggests that the subjects had attained a level of cognitive development which allowed them to utilize schemas facilitating to this task.

The results of the present study were complex. The significant main effect for age was supportive of recent research which asserted the developmental nature of memory. In addition, there was mild support for Piaget's proposal that memory and level of cognitive development are related: i.e., normals' performance on the memory tasks was significantly superior to retardates'. However, repeated measure and trend analyses indicated an inverse relationship between time and recall. These results did not uphold earlier findings - findings that suggested that quality of recall increases as a function of time.

There is need for a more critical analysis of the relationship between memory and operativity. Assessment of cognitive development at the time of recall (immediate, one week, and six months) would be desirable. These analyses would determine the validity of the Genevan proposal that an individual's level of cognitive development influences his performance in a memory experiment.

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MEMORY AND MENTAL IMAGERY IN RETARDATES: A PILOT STUDY

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INTRODUCTION

Included in the vast amount of literature flowing from the hand of Piaget and his collaborators in recent years is a variety of insightful studies dealing with memory. Piaget (1968) holds that memory is a special case of intellectual activity, applied to reconstruction of the past rather than to knowledge of the present or anticipation of the future. That is, memory performance is not simply determined by one's perception or memtal image; operative schemes or mental operations also influence the way in which a person understands and remembers certain configurations (Inhelder, 1969). "Operations" are defined (Inhelder, 1968) as actions - mental actions - which can be internalized and which are reversible; for example, addition and subtraction are operations. A "scheme" is the part of an action that is transferable to the same situations when the reoccur or is generalizable to similar situations. Thus, operative schemes are active mental structures which can be modified by assimilating information from environment or accommodating to it. A visual stimulus is "decoded" in terms of a person's existing mental structures. Memory images are linked to operational schemes which control the images and dominate the model perceived. Hence, "the memory image is not a simple residue of the perception of the model, but rather a symbol that corresponds to the schemes of the child (Inhelder, 1969, p. 343)." What happens

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* Graduate students at Temple University who participated in the study include:

Susan Henry
Stanley Rude
Libby Goodman
Angelo Merola
Stanley Hamburger
Lee Weiderholt
Morris Peterkin
Maureen Pruitt
Helene Gerstein

when the child is asked to reconstruct (draw) something seen once after an elapsed period of time is indicative of, and a function of, progress in operational thinking.

In order to test the hypothesis that the memory code depends on the individual's operations, and that this code is modified during cognitive development - depending at any given moment on the person's operational level - Piaget (1968) presented a group of children (CA 3-8) with a card on which had been glued 10 sticks arranged vertically in order of decreasing length. The children were instructed to look at the sticks closely because they would be asked to remember them later. After one week, and without again seeing the array of sticks, the children were asked to draw what they had seen. A second set of drawings was collected after six months; again the children drew from memory: they were not presented the seriated sticks. A comparison of the one-week and six-months drawings showed a 74% improvement in recall after six months for the whole group, CA 3-3; (i.e., when six-month drawings were compared with one-week drawings); 90% improvement occurred for those children between the ages of five and eight. These results were confirmed in a second experiment conducted by Piaget (using a slightly more difficult arrangement of sticks), and were later replicated by Altemeyer, Dalton, and Berney (1969). Piaget interprets these results as lending support to the hypothesis that the memory image reflects the subject's assimilation schemas (the way in which he understands the model), and that development of schemes explain the progress of memory.

In describing his results, Piaget stated that children in the 6-7 year age range correctly represented the seriated array of sticks (ordered by size and with about the correct number of sticks). Subjects in the 5-6 year age range had drawings which showed the correct seriation of sticks, but the number of sticks

was incomplete. For the 4-5 year group the tendency was to see the array dichotomously - big and little sticks only; for those in the 3-4 year age range drawing usually consisted of a number of sticks of equal length. This system of mental image reproduction roughly corresponds to the development of seriation as related to number conception (Piaget, 1952; Elkind, 1968). Piaget found three stages when he presented children with a bundle of 10 sticks of varying lengths:

Stage 1 (global): at approximately CA 4, children are generally able only to seriate a small number of sticks (3-4).

Stage 2 (intuitive representation): at approximately CA 5, the correct seriation can be constructed, but only after much trial and error.

Stage 3 (operational concept): usually at CA 6-7, the child is able to seriate the sticks correctly, as the relational concept involved (seriation) has become internalized, and assumes the characteristics of logical operations.

In short, the younger child is perceptually bound to the array whereas the older child operates conceptually: "...he has abstracted a principle and.....can generate the patterned array through memory of a simple rule, rather than through memory of the whole array (Altemeyer, et al., 1969)."

Thus schemes or processes of seriation form a "code" for memorizing the array of sticks, and the supposed relation between operative aspects of cognition (actions or operations) and figurative aspects (perception and mental imagery) is maintained. In the six-month interval before the second drawing was requested, these schemes or mental operations of seriation developed and were modified through spontaneous functioning as the child interacted with his environment (e.g. encountered and handled objects of differeing sizes), which accounts for the conservation and/or improvement in the represented mental image.

PROBLEM

In the present pilot study normals and retardates were compared in their ability to draw (reproduce) ten seriated sticks after intervals of one week and six months. Interest was not merely in replicating the work of Piaget with the normal sample, but in determining whether the same pattern of improvement is found in the retarded. Research (Inhelder, 1968, Stephens, Miller & McLaughlin, 1969) has shown that the retarded undergo the same processes of development but at a slower rate than normals and that the retarded tend to become fixated at lower levels of reasoning. Given this slower tempo of development, how will the retarded perform on similar tasks involving memory and mental image? To determine the role of physical maturation and amount of environmental interaction in the area of memory, the retarded subjects were compared with normal subjects of equivalent MA. It was the hypothesis that the retarded, in spite of greater CA's, would not differ significantly from normal subjects of equivalent MA on the initial (one-week) memory drawing, but that they would not show the same improvement following a six-month interval.

METHODOLOGY

Sample: The sample was composed of 35 mentally retarded subjects, CA 6-13, MA 3-6 (determined by the Stanford-Binet and WISC), and 35 normal subjects, CA and MA 3-6. Mentally retarded subjects were the total number of resident students at Bancroft School (Haddonfield, N. J.) and Woods School (Langhorne, Penna.) who were enrolled in pre-school classes. Normal subjects were randomly drawn from children enrolled in pre-school programs at Newtown Friends School (Newton, Pa.) and a Head-Start class at Temple University (Philadelphia, Pa.).

Procedure: Subjects were shown (individually) a card on which had been glued the ten sticks arranged in order of decreasing length. No limit was placed on

the length of time the children were permitted to view the card. Instructions were to study the array closely because they would be questioned on it at a later time. One week later, and again at six months, memory drawings of the sticks were solicited from each subject. Because performance involved random or irrelevant drawings as well as the progression from equalities to a seriation of two to four or more sticks reported by Piaget, a simple one to five scoring system was devised:

1 = no response (blank page)

2 = random or irrelevant

3 = some indication of seriation

4 = seriation but incomplete (less than four sticks)

5 = correct seriation with five or more sticks drawn

Inter-rater reliability of .98 was obtained on scoring of drawings by two judges.

Data Analysis and Results: Because of the small sample size a non-parametric test of significance (Wilcoxon Matched-Paird signed-Rank Test; Runyon and Haber, 1967) was used in comparing the performance of the two groups. The number is set forth in Table 1.

INSERT TABLE 1

Review of these data indicates:

- seven of the normals who showed improvement increased by only one point (three increased from '2' to '3', one from '3' to '4', and three from '4' to '5'); one subject increased from '3' to '5'; and one subject went from '1' to '5'.
- improvement of the five retardates involved a one-point increase in each case (one subject increased from '1' to '2'; one from '3' to '4'; and three from '2' to '3').

- of the 12 normals who showed a decrease in performance, six reduced their score by only one point, three by two points, one by three points, and two by four points.
- three of the retardates decreased by one point, five by two points, three by three points, and one by four points.
- differences in performance at one week between normals and retardates were not significant (T-99); differences in performance (T=139) at the end of six months were significant at the .05 level (Wilcoxon Signed-Rank)

Perfect scores (5) on the one week drawing were obtained by 12 normals and six retardates. At the end of six months, ten normals and three retardates scored perfectly. The mean scores for the total sample (35 normals, 35 retardates) on the one-week drawings were: normals, 3.43; retardates, 2.97. The mean scores at the end of six months were: normals, 3.11; retardates, 2.37.

Mean scores for the three age groups of normals and the three age groups of retardates for performance at the end of one week and at the end of six months is presented in Table 2.

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INSERT TABLE 2
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When the Wilcoxon Signed-Rank Test is used to compare performance of normals and retardates at the MA 3 level statistically significant differences are found at the end of one week or at the end of six months. At MA 4 and 5 differences between the two groups are not sifnificant on the one-week drawings, but drawings by normals at the end of six months are significantly superior (.05) to those of retardates.

The data seem to suggest that significant improvement over time does not occur in the performance of normals or retardates whose MA is less than 6 years. In

fact, performance decreases in all instances except in normals of MA 6. Although the increase in the mean score is only .25 for normals MA 6, the minimal score serves to suggest that schemes which, according to Piaget, promote improvement in performance are being initiated. If this is true, a similar study which uses subjects MA 6-8 should reveal significant improvement between the six to eight-year age levels. The results would confirm the findings of Piaget (1968) and Altemeyer, et al. (1969). What the present findings appear to indicate is that improvement does not occur prior to the development of an understanding of seriation which, as previously noted (Piaget, 1952; Elkind, 1968), occurs in normals at approximately six to seven years of age.

SUMMARY

Significant improvement did not occur in performance of normal or retarded subjects of MA 3-6 when scores for drawings which occurred one week after viewing seriated sticks were compared with drawings at the end of six months. However, the fact that there was slight improvement at the end of six months for normal subjects of MA 6 (4.75 to 5.00) gives some indication that schemes of seriation are being established.

Despite the fact that the three groups of retardates and three groups of normals were of equal MA (MA 3, MA 4-5, MA 6) the performance of the normals exceeded that of the retardates (mean scores) on all but the MA 3 level. This suggests that the functioning of retardates MA 4 and above is not comparable to normals of equal MA in the area of memory and mental imagery. Additional experience afforded by increased CA does not seem to benefit the performance of the retarded in these areas.

The mean scores at the three MA levels, three, four-to-five, and six, indicate consistent improvement among the normals with increased age on both one week

and six month drawings. At one week scores for retardates showed slight improvement across MA's; by comparison, retardates' drawings at the end of six months were practically static: i.e., very little or no improvement occurred across age ranges. There is the suggestion that conditions present in the mentally retarded preclude the improvement noted in normals of equivalent MA.

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TABLE 1

DIFFERENCES BETWEEN ONE-WEEK AND SIX-MONTH SCORES

	Increase	Same	Decrease	
Normals	9	14	12	= 35
Retardates	5	18	12	= 35

TABLE 2

SCORES ON DRAWINGS FOR NORMALS AND RETARDATES

MA	Sample	N	One-Week Mean	Six Month Mean
3	Normals	9	2.56	2.11
	Retardates	9	2.89	2.33
4 & 5	Normals	22	3.50	3.18
	Retardates	22	2.95	2.40
6	Normals	4	4.75	5.00
	Retardates	4	3.25	2.25